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Development of a Robust Setup for the Study of Wetting Characteristics of Low Melting Point Metals

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Development of a Robust Setup for the Study of Wetting Characteristics of Low Melting Point Metals

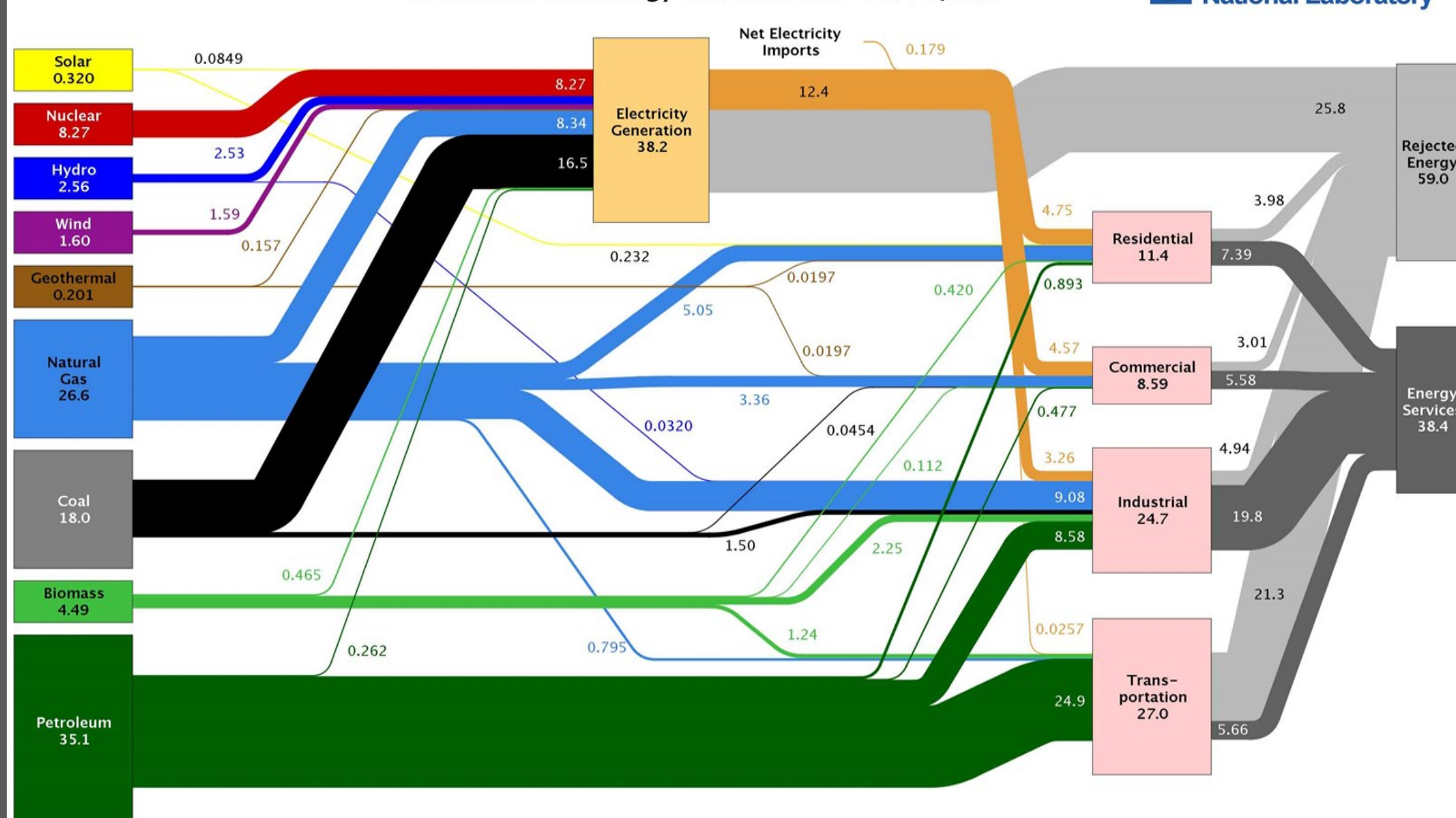


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Motivation

- Energy use is very inefficient
 - Approx. 60% rejected mostly in the form of waste heat
- Low melting point metals are promising for applications in thermal energy management, conversion, and storage

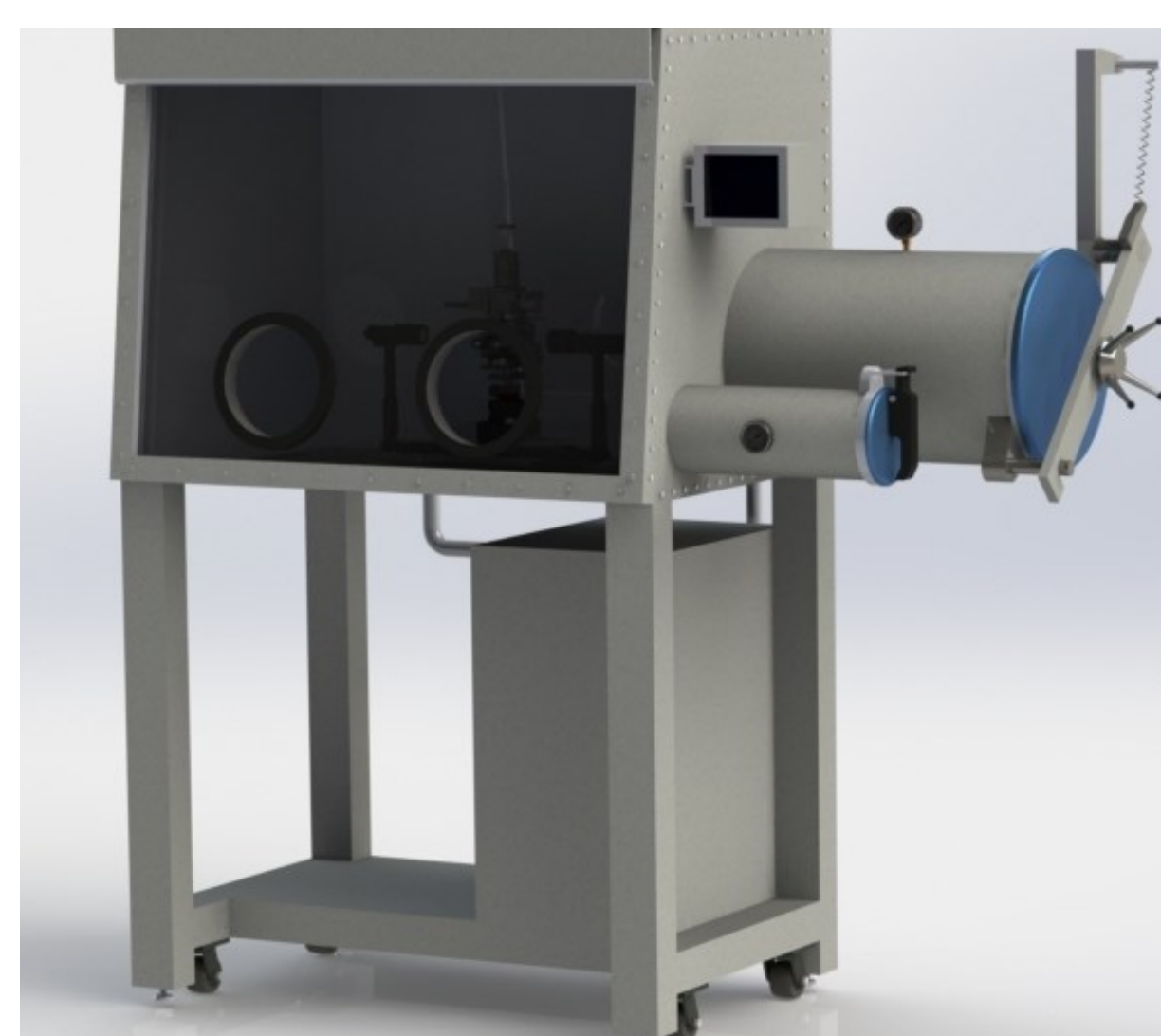
Estimated U.S. Energy Use in 2013: ~97.4 Quads



Above: Energy use in the US for the year 2013. The figure shows approximately 60% of energy is rejected. Retrieved from: www.llnl.gov/missions/energy

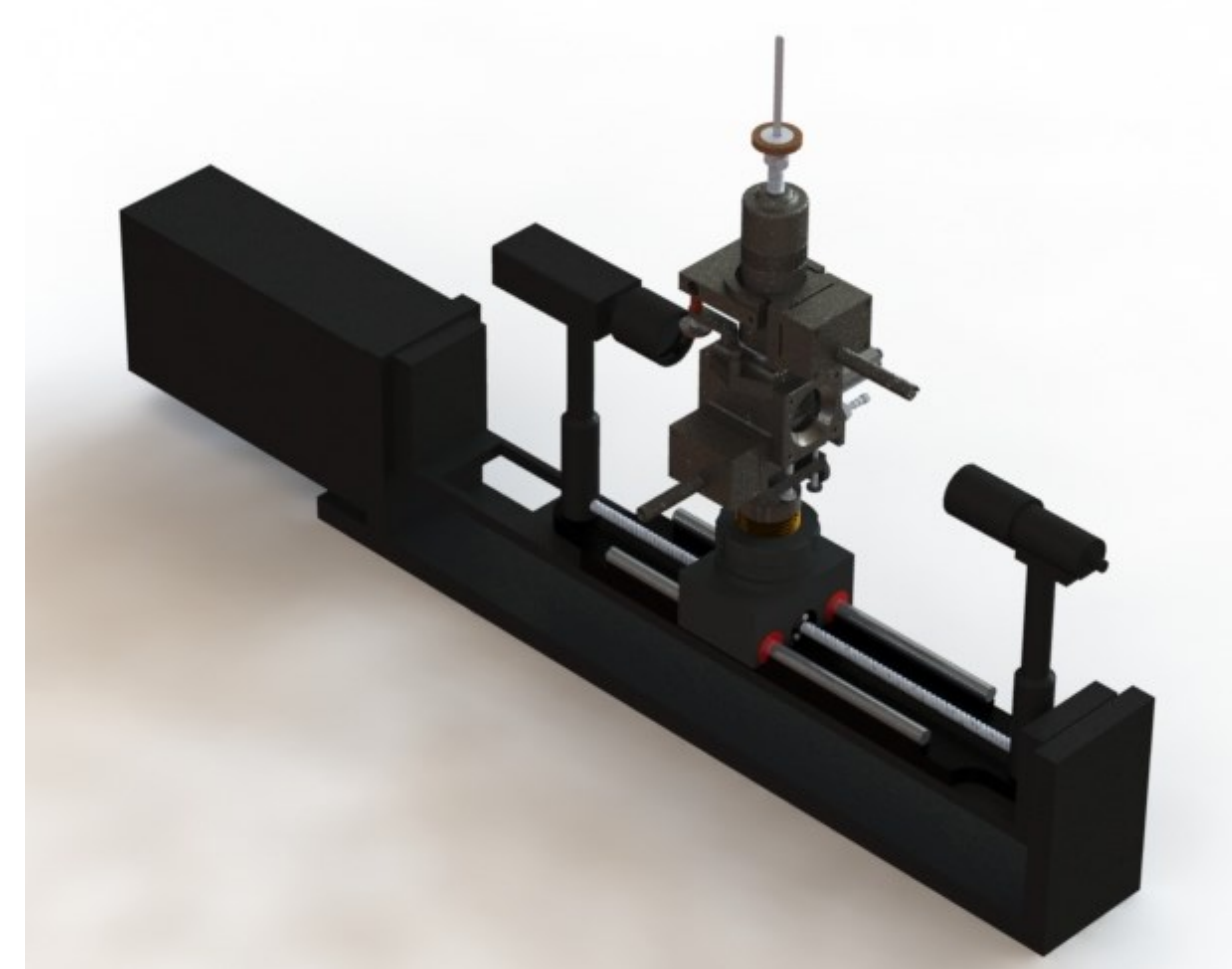
Experimental Equipment

MBRAUN LABstar Glove Box



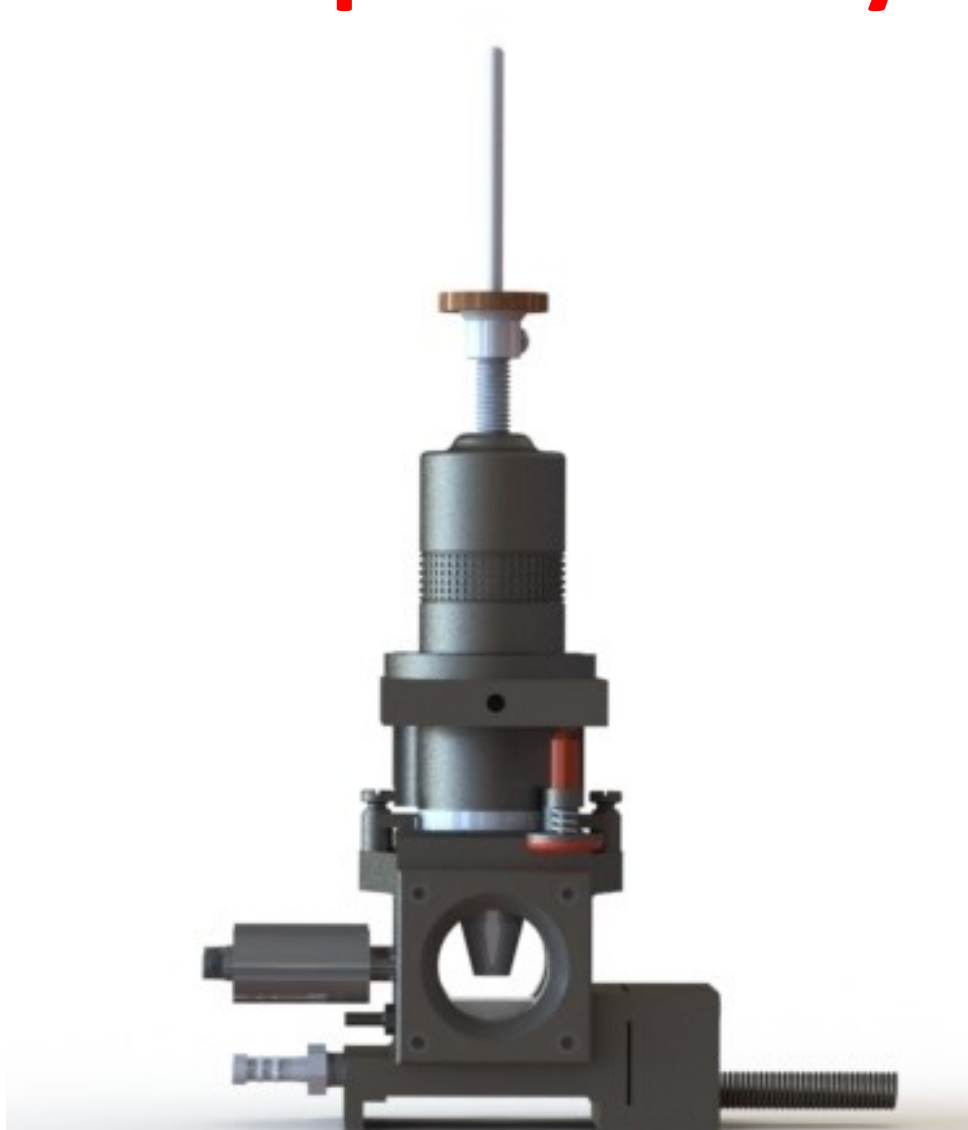
- Inert gas environment
- O_2 levels < 0.5 ppm
- H_2O levels < 0.5 ppm
- Pressure control

Rame-Hart Model 250 Goniometer



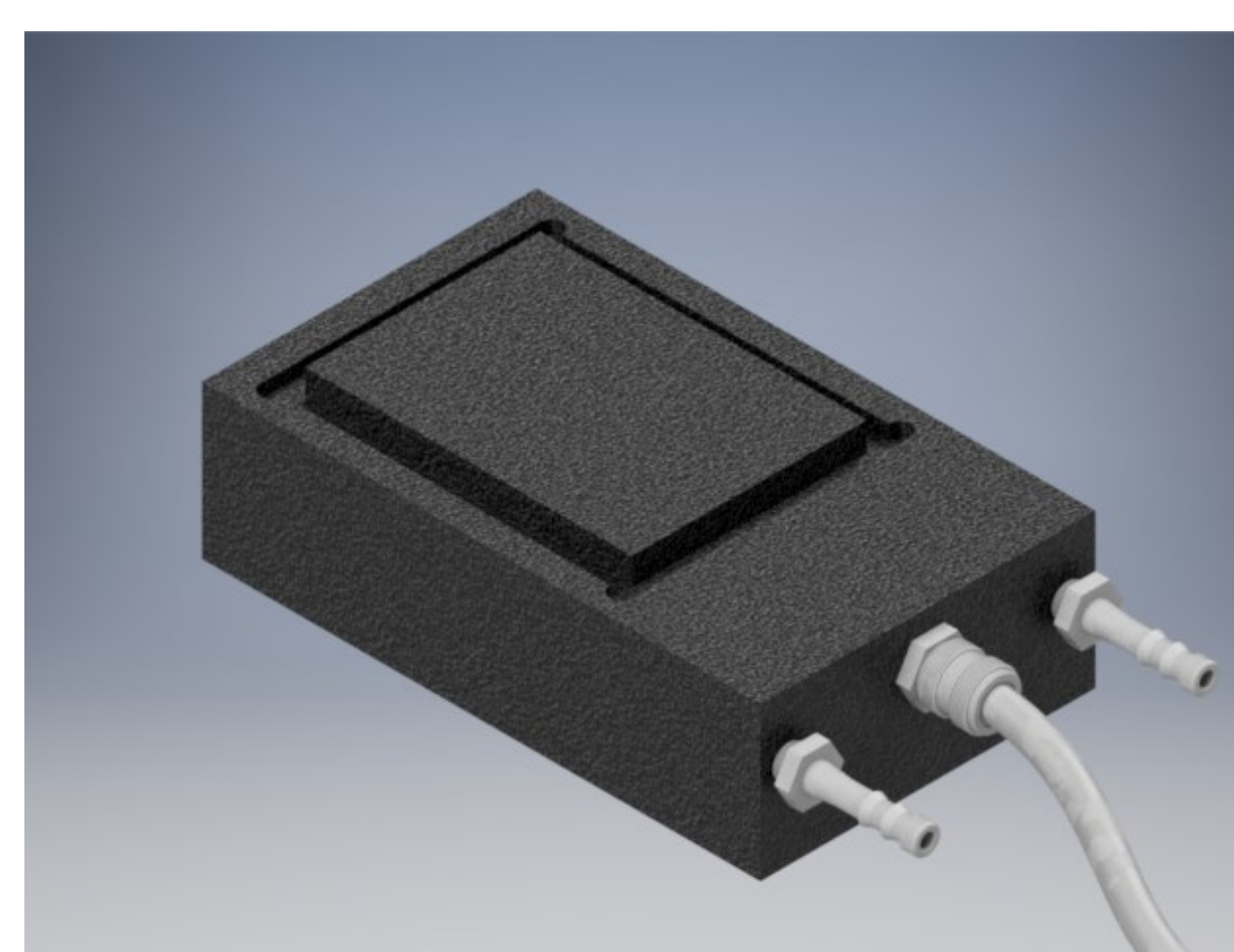
- Measures
 - Contact angle
 - Surface tension
- Adjustable stage

Rame-Hart Elevated Temperature Syringe



- Provides an elevated temperature up to 300° C
- Fluid may be dispensed at a temperature equivalent to the sample surface
- Reduces the temperature gradient across the droplet

Rame-Hart Hot Plate



- Provides an elevated sample temperature up to 300° C
- Can be cooled to well below ambient temperature

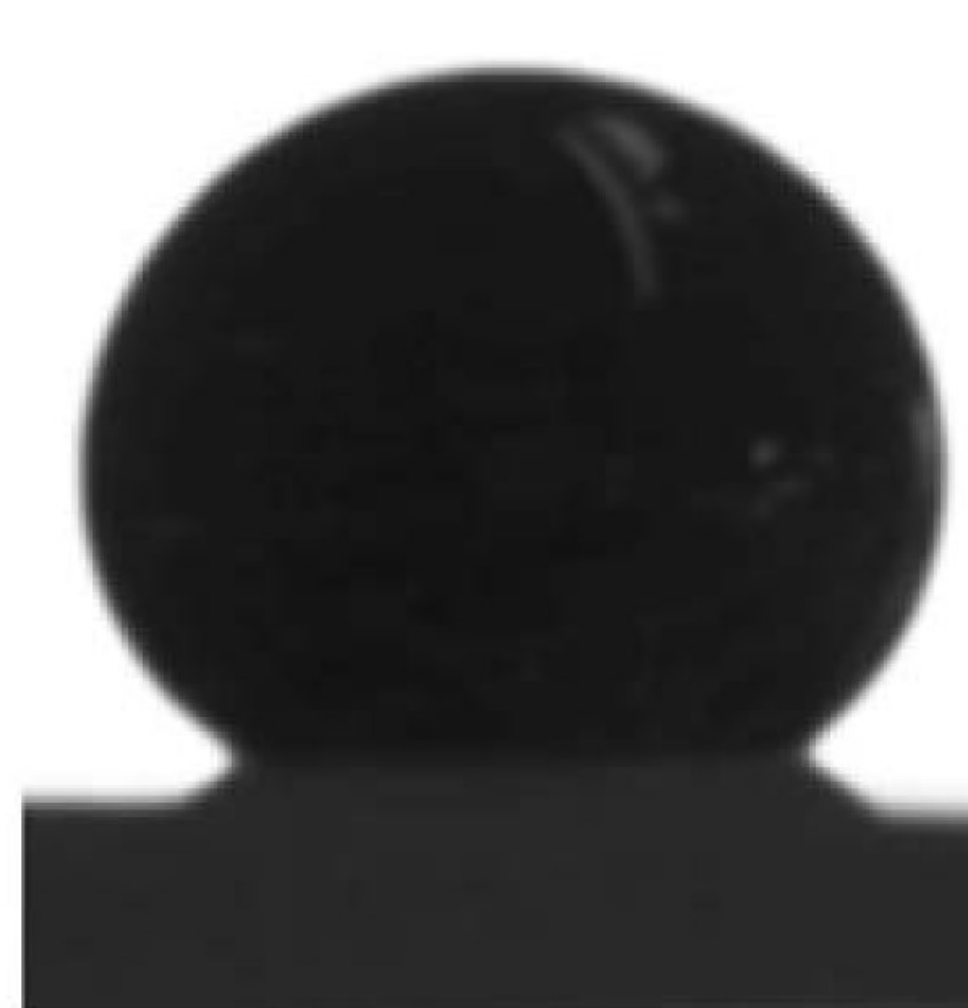
Low Melting Point Metals

Appealing Properties

- High thermal conductivity
- Low melting temperature
- Good electrical conductivity
- Small volume expansion during phase change
- High boiling point
- Large latent heat of phase change

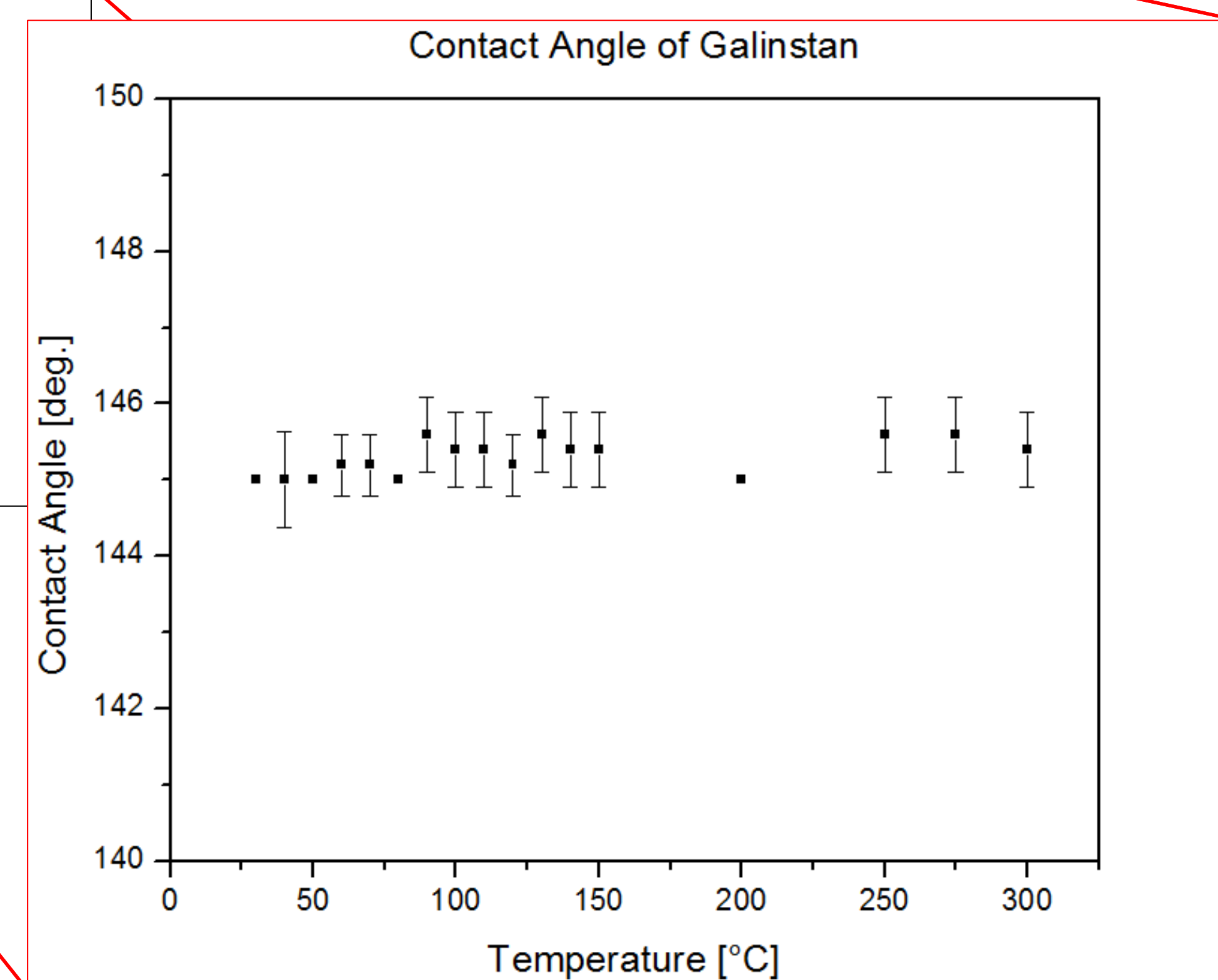
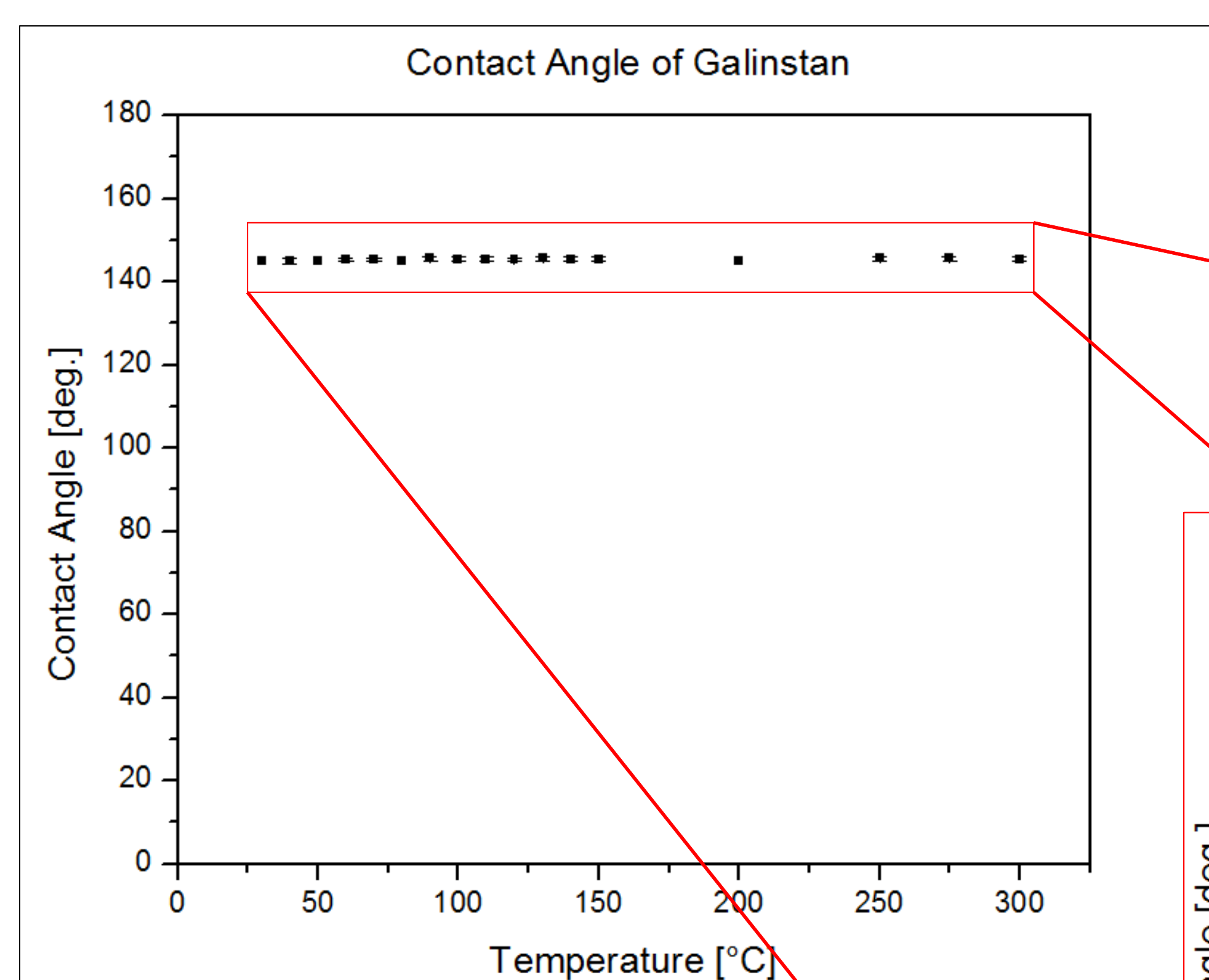
Adverse Characteristics

- Oxidize readily at > 1 ppm oxygen
 - Must be handled in inert environment



Liu, T.; Sen, P.; Kim, C. J. Characterization of Nontoxic Liquid-Metal Alloy Galinstan for Applications in Microdevices. *J. Microelectromechanical Syst.* **2012**, *21*, 443–450.

Preliminary Results and Future Work



Results

- Contact angle of Galinstan on silicon is ~145° above 30°C regardless of temperature

Future Work

- Contact angles of Galinstan below ambient
- Various substrate materials
 - Tungsten, Pyrex, Tantalum, etc.
- Various low melting point metals.
 - Gallium, Indium, Tin, Bismuth alloys



Acknowledgements

This work has been supported by